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July 1979

ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1978

A. Aarkrog, Heinz Hansen and J. Lippert

Abstract. Measurements of fallout radioactivity in the Faroes in 1978 are presented. Strontium-90 (and ^{137}Cs in most cases) was determined in regularly collected samples of precipitation, grass, milk, fish, sea water, bread, and drinking water. In addition, analyses were made of spot samples of lamb, sea birds, potatoes, sea plants, vegetables, eggs, and human bone. Tritium was determined in samples of drinking water. Estimates are given of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in the Faroes in 1978.

INIS Descriptors

[0] DIET, ENVIRONEMNT, EXPERIMENTAL DATA, FAROE ISLANDS, FISHES, FOOD, FOOD CHAINS, GLOBAL FALLOUT, GRAPHS, MILK, PLANTS, RADIOACTIVITY, SEAWATER, SHEEP, TABLES

[1] ATMOSPHERIC PRECIPITATIONS, BONE TISSUES, DRINKING WATER, MAN, STRONTIUM 90

[2] CESIUM 137

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ABBREVIATIONS AND UNITS

FP	fission products
pCi	picocurie, 10^{-12} Ci μμCi
nCi	nanocurie, 10^{-9} Ci, mμCi
mCi	millicurie, 10^{-3} Ci
MPC	maximum permissible concentration
S.U.	pCi ^{90}Sr (g Ca)$^{-1}$
O.R.	observed ratio
M.U.	pCi ^{137}Cs (g K)$^{-1}$
nSr	natural (stable) Sr
S.D.	standard deviation, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{(n-1)}}$
S.E.	standard error, $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{n(n-1)}}$
S.S.D.	sum of squares of deviations, $\Sigma(\bar{x}-x_i)^2$
f	degrees of freedom
s^2	variance
v^2	ratio between the variance in question and the residual variance
$\bar{x}$	mean values
Σ	sum
η	coefficient of variation, relative standard deviation: $\frac{SD}{\bar{x}}$
A:	η: 20-33% (due to counting)
B:	η: >33% (due to counting)
B.D.L.	below detection limit

1. INTRODUCTION

1.1.

The fallout programme for the Faroes, which was initiated in 1962[1] in close co-operation with the National Health Service and the chief physician of the Faroes, was continued in 1978. Samples of human bone were obtained in 1978 from Dronning Alexandrine's Hospital in Thorshavn.

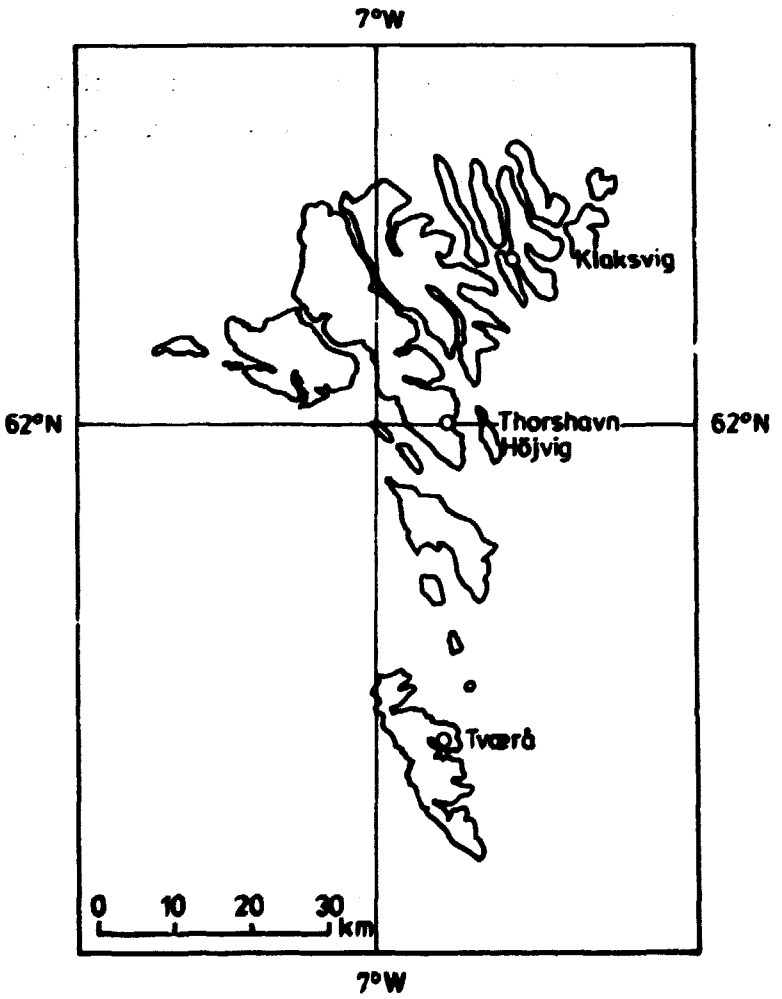

Fig. 1. The Faroese Islands

1.2.

The present report will not repeat information concerning sample collection and analysis already given in Risø Reports Nos. 64, 86, 108, 131, 155, 181, 202, 221, 246, 266, 292, 306, 324, 346, 361 and 387[1].

1.3.

The estimated mean diet of the Faroese as used in this report is still based on the estimate given by Professor E. Hoff-Jørgensen, Ph.D., in 1962.

1.4.

The present investigation was carried out together with corresponding examinations of fallout levels in Denmark and Greenland, described in Risø Reports Nos. 403[2] and 405[3] respectively.

2. RESULTS AND DISCUSSION

2.1. Strontium-90 in precipitation

Table 2.1 shows the ^{90}Sr content in precipitation collected at Højvig (near Thorshavn) and Klaksvig in 1978. The amount of fallout at Klaksvig was a factor of 1.3 greater than that found at Højvig.

The ^{90}Sr fallout in 1978 was approx. 1.3 times of the 1977 levels in the Faroes. In Denmark the 1978 levels were 1.2 times higher than the 1977 levels[2].

Table 2.1. Strontium-90 in precipitation in the Faroes in 1978

	Højvig		Klaksvig	
	pCi $^{90}Sr\ l^{-1}$	mCi $^{90}Sr\ km^{-2}$	pCi $^{90}Sr\ l^{-1}$	mCi $^{90}Sr\ km^{-2}$
Jan	0.80	0.102	1.37	0.139
Feb	1.17	0.060	1.54	0.079
March	1.15	0.149	1.95	0.253
April	3.81	0.070	4.32	0.170
May	2.16	0.057	(2.57)	(0.070)
June	2.15	0.083	1.49	0.076
July	2.39	0.090	1.09	0.095
Aug	1.00	0.095	1.08	0.091
Sept	0.50	0.126	0.92	0.116
Oct	0.25	0.068	0.33	0.081
Nov	0.30	0.075	0.37	0.076
Dec	0.74	0.032	0.94	0.040
1978	$\bar{x}$ 0.75	Σ 1.007	$\bar{x}$ 1.08	Σ 1.286
		Σ_{mm} 1343		Σ_{mm} 1187

Figures in brackets calculated from VAR 3[12].

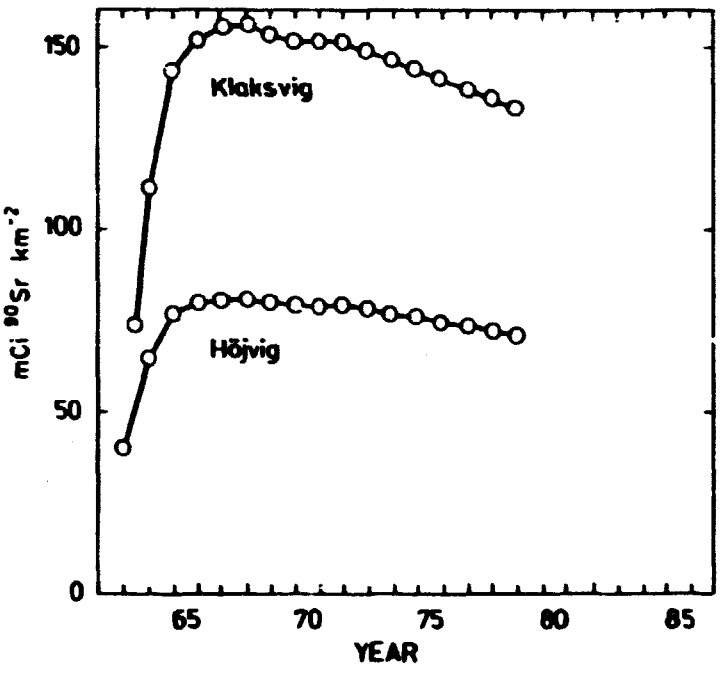

Fig. 2.1. Accumulated ^{90}Sr at Klaksvig and Højvig calculated from precipitation measurements since 1962. The accumulated fallout by 1962 was estimated from the Danish fallout data (cf. Risø Report No. 403[2], Appendix D) and from the ratio between the ^{90}Sr fallout at the Faroese stations and the fallout in Denmark in the period 1962-1974.

2.2. Strontium-90 and Cesium-137 in grass

Grass samples were collected near Thorshavn in 1978. Table 2.2 shows the results. The 1978 S.U. level in grass was nearly equal to the 1977 level. As compared with Danish grass in 1978[2], we found the S.U. level in the Faroese grass to be higher by a factor of approx. 4 in the summer months.

Table 2.2. Strontium-90 and Cesium-137 in grass from Thorshavn 1978

Month	pCi ^{90}Sr kg^{-1}	pCi ^{90}Sr (g Ca)$^{-1}$	pCi ^{137}Cs kg^{-1}	^{137}Cs/^{90}Sr
June	43	294	206	4.79
August	225	79	2069	9.20

2.3. Strontium-90 and Cesium-137 in milk

As in previous years[1)], weekly samples of fresh milk were obtained from Thorshavn, Klaksvig, and Tværå. Strontium-90 and ^{137}Cs were determined in bulked monthly samples.

Table 2.3.1 shows the results and tables 2.3.2, 2.3.3 and 2.3.4 the analysis of variance of the S.U., M.U., and pCi ^{137}Cs l^{-1} figures respectively. As also observed in previous years, the variation between locations was highly significant for ^{137}Cs as well as for ^{90}Sr. The highest ^{90}Sr levels were found in the milk from Tværå. Thorshavn showed lower ^{137}Cs concentrations in milk than Klaksvig and Tværå.

Table 2.3.1. Strontium-90 and Cesium-137 in milk from the Faroes in 1978

Month	Thorshavn			Klaksvig			Tværå			Mean		
	S.U.	pCi ^{137}Cs l^{-1}	M.U.	S.U.	pCi ^{137}Cs l^{-1}	M.U.	S.U.	pCi ^{137}Cs l^{-1}	M.U.	S.U.	pCi ^{137}Cs l^{-1}	M.U.
Jan	7.9	85	49	6.3	328	214	9.8	81	47	8.0	165	103
Feb	4.9	45	26	7.5	169	96	9.9	218	127	7.4	144	83
March	7.3	104	62	5.3	238	140	8.7	219	127	7.1	187	110
April	4.1	118	64	6.6	191	114	8.7	210	121	6.5	173	100
May	7.3	68	41	7.6	164	88	13.1	216	122	9.3	149	84
June	10.3	112	62	6.8	188	115	10.6	227	134	9.2	176	104
July	12.2	143	88	7.8	218	143	12.1	274	170	10.7	212	134
Aug	9.1	107	67	7.5	206	162	13.3	328	209	10.0	214	146
Sept	9.9	162	104	8.3	268	171	9.2	216	128	9.1	215	134
Oct	8.5	111	66	7.2	320	208	8.4	122	70	8.0	184	115
Nov	5.4	53	37	7.6	212	183	9.9	284	136	7.6	183	119
Dec	6.3	61	38	6.7	198	111	7.7	183	110	6.7	147	86
Mean	7.8	97	59	7.1	225	145	10.1	215	125	8.3	179	110

Table 2.3.2. Analysis of variance of ln ^{90}Sr (g Ca)$^{-1}$ in Faroese milk in 1978 (from Table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Between months	0.876	11	0.080	2.139	-
Between locations	0.803	2	0.401	10.783	>99.9%
Remainder	0.819	22	0.037		

Table 2.3.3. Analysis of variance of ln ^{137}Cs (g K)$^{-1}$ in Faroese milk in 1978 (from Table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Between months	1.618	11	0.147	1.215	-
Between locations	6.109	2	3.055	25.216	>99.95%
Remainder	2.665	22	0.121		

Table 2.3.4. Analysis of variance of ln pCi ^{137}Cs l^{-1} in Faroese milk in 1978 (from Table 2.3.1)

Variation	SSD	f	s^2	v^2	P
Between months	1.184	11	0.108	0.862	-
Between locations	5.856	2	2.928	23.435	>99.95%
Remainder	2.749	22	0.125		

Figure 2.3.1 shows the quarterly S.U. values and fig. 2.3.2 the quarterly pCi ^{137}Cs l^{-1} levels since 1962. The annual mean values for 1978 were 8.3 S.U. (≈ 10 pCi ^{90}Sr l^{-1}) and 110 M.U., or 179 pCi ^{137}Cs l^{-1}, i.e. the ^{90}Sr levels in 1978 were approx. 80% of the 1977 mean levels, while the ^{137}Cs levels were nearly unchanged.

The annual mean values of the M.U./S.U. ratio in Faroese milk are shown in fig. 2.3.3.

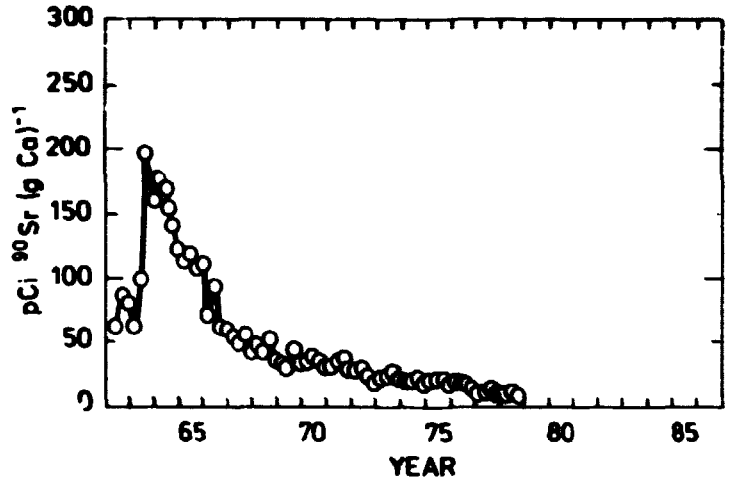

Fig. 2.3.1. Strontium-90 in Faroese milk, 1962-1978.

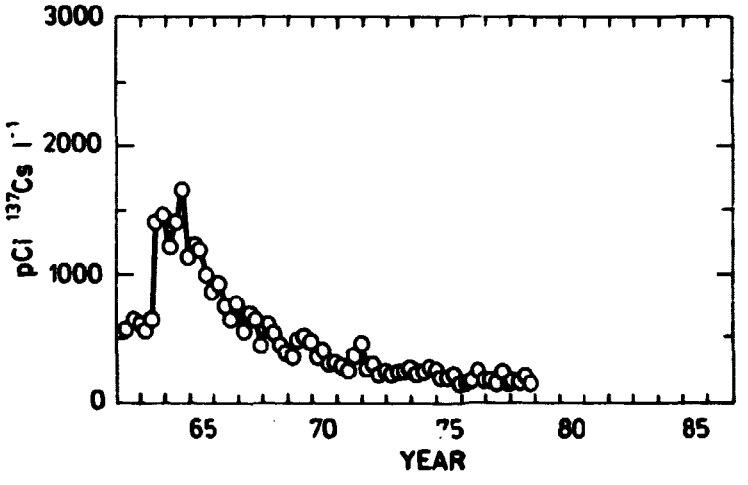

Fig. 2.3.2. Cesium-137 in Faroese milk, 1962-1978.

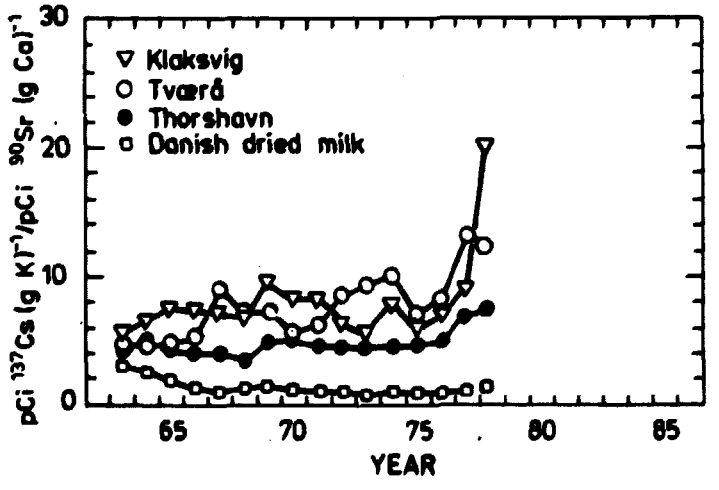

Fig. 2.3.3. $\frac{M.U.}{S.U.}$ ratios in Faroese and Danish milk, 1963-1978.

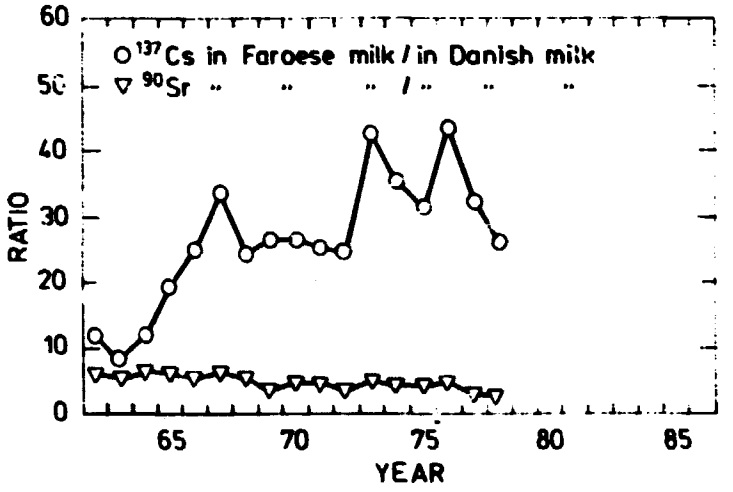

Fig. 2.3.4. A comparison between Faroese and Danish milk levels, 1962-1978.

The mean M.U./S.U. ratio in 1977 was 9.0 ± 0.9 (1SE) during the grazing period (May-October), and in the winter time it was 10.4 ± 1.3.

Figure 2.3.4 shows a comparison between the ^{90}Sr and ^{137}Cs levels in Faroese- and Danish-produced milk. It is evident that indirect contamination plays an important role for the ^{137}Cs levels in the Faroes, because the ratio between ^{137}Cs in Faroese and Danish milk increases with time. The ratios between the ^{90}Sr levels in Faroese and Danish milk have shown a slight tendency to decrease through the years.

2.4. Strontium-90 and Cesium-137 in terrestrial animals

The 1978 mean levels in 3 samples of mutton were 3.9 pCi ^{90}Sr kg^{-1}, or 49 S.U., and 1.02 nCi ^{137}Cs kg^{-1}, or 374 M.U. The bone level was 74 pCi ^{90}Sr (g Ca)$^{-1}$.

Table 2.4. Strontium-90 and Cesium-137 in lamb samples from the Faroes in October 1978

Location	Sample type	pCi ^{90}Sr kg^{-1}	pCi ^{90}Sr (g Ca)$^{-1}$	pCi ^{137}Cs kg^{-1}	pCi ^{137}Cs (g K)$^{-1}$
Klaksvig	Meat	6.2	76	2706	982
- " -	Bone	-	56	-	-
Tvøroyri	Meat	3.7	42	131	53
- " -	Bone	-	122	-	-
Kirkjubour	Meat	1.93	30	222	87

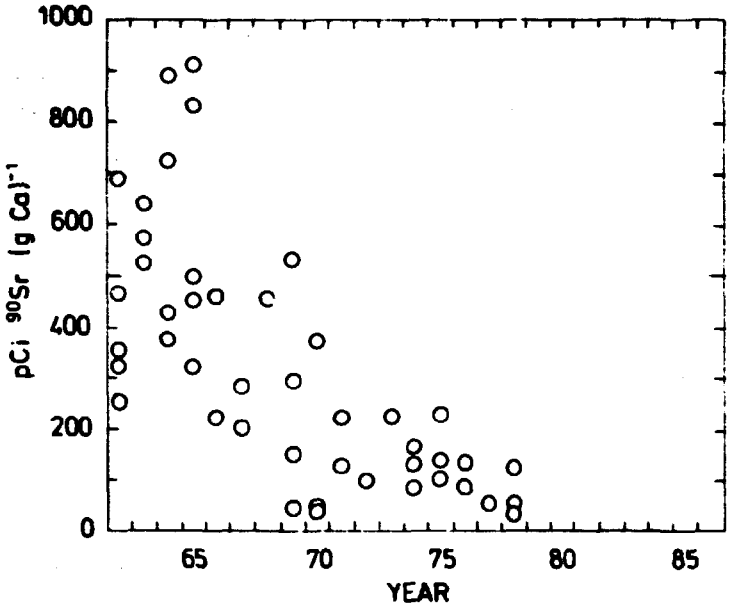

Fig. 2.4.1. Strontium-90 (pCi (g Ca)$^{-1}$) in lamb bone collected in the Faroes, 1962-1978.

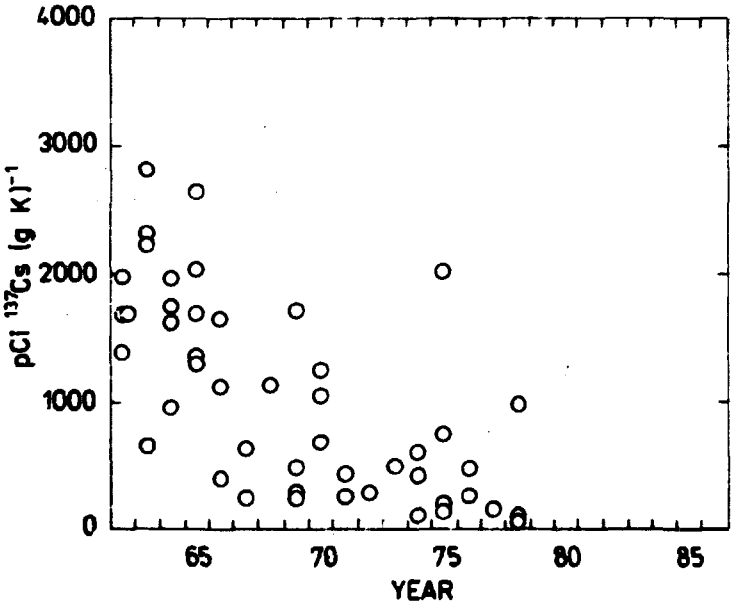

Fig. 2.4.2. Cesium-137 (pCi (g K)$^{-1}$) in lamb meat collected in the Faroes, 1962-1978.

2.5. Strontium-90 and Cesium-137 in sea animals

Table 2.5.1 shows the ^{90}Sr and ^{137}Cs levels in fish collected in 1978 in the Faroes. The mean levels in Gadus aeglefinus and Gadus callarias were 0.24 pCi ^{90}Sr kg^{-1} and 7.9 pCi ^{137}Cs kg^{-1} (S.E.: 1).

Table 2.5.1. Strontium-90 and Cesium-137 in sea animals from the Faroes in 1978

Sampling month	Species	Sample type	pCi $^{90}Sr\ kg^{-1}$	pCi ^{90}Sr (g Ca)$^{-1}$	pCi $^{137}Cs\ kg^{-1}$	pCi ^{137}Cs (g K)$^{-1}$
Jan	Fish Gadus aeglefinus	Meat	0.68	10.1	5.3	
June	" - " -	"	0.046	0.68	5.3	
Oct	" - " -	"	0.193	2.0	6.7	
Nov	" - " -	"	0.28	2.9	6.9	
Jan	Fish Gadus callarias	Meat			9.5	
March	" - " -	"	0.181	2.8	10.9	
June	" - " -	"	0.24	1.40	4.7	
Oct	" - " -	"	0.105	0.36	13.6	
Nov	" - " -	"	0.23	2.0	8.3	
Aug	Whale	Meat	B.D.L.	B.D.L.	29	11.5
"	- " -	Blubber	-	-	5.3	10.2
"	- " -	Bone	-	0.050	-	-
June	Bird Guillemot	Meat	B.D.L.	B.D.L.	11.0 A	2.9 A
"	" - " -	Bone	-	0.21 B	-	-

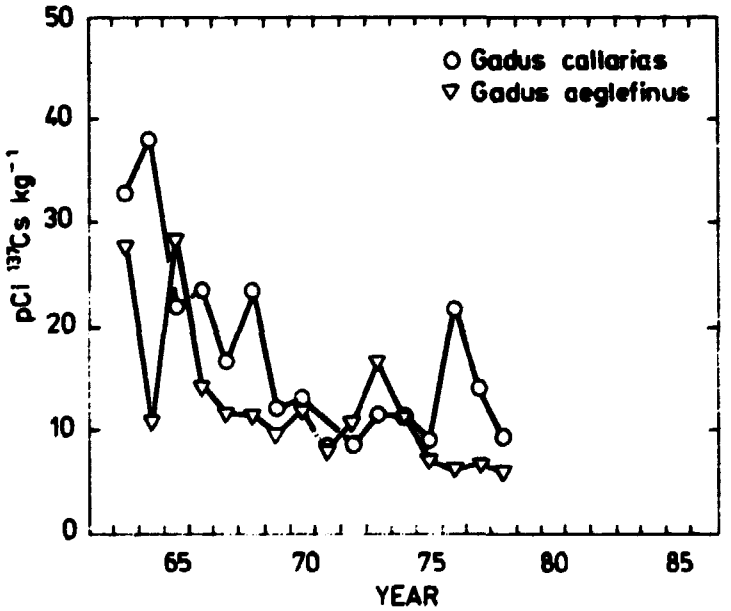

Fig. 2.5.1. Cesium-137 levels in meat of cod (Gadus callarias) and Haddock (Gadus aeglefinus) collected in the Faroes, 1962-1978.

2.6. Strontium-90 in drinking water

Drinking-water samples were collected as previously but the sample were combined before the analysis as shown in table (table 2.6.1). As in previous years, drinking water from Thorshavn contained more ^{90}Sr than that from Tværå (cf. the explanation in Risø Report No. 181[1]). The concentrations in drinking water from Klaksvig were 3.5 times less in 1978 than in 1977.

Figure 2.6.1 shows the annual mean levels of ^{90}Sr in drinking water from the three locations since 1962.

The mean level in 1978 was 0.15 pCi ^{90}Sr l^{-1}, i.e. a little lower than the 1977 level.

Tritium was measured in some samples (table 2.6.2). The concentrations were similar to those in Greenland drinking water[3], and 3 orders of magnitude higher than the ^{90}Sr levels, i.e. similar to the ratios found in Danish stream and lake water[2].

Table 2.6.1. Strontium-90 in drinking water from the Faroes in 1978 (Unit: pCi l^{-1})

	Thorshavn	Klaksvig	Tværå
Jan-June	0.31	0.027 A	0.156
July-Dec	0.22	0.040	0.146
1978	0.27	0.034	0.151

Table 2.6.2. Tritium in drinking water from the Faroes in 1978

Location	Month	^{3}H nCi l^{-1}
Klaksvig	July	0.12
- " -	Sept	0.10±0.02
- " -	Nov	0.14±0.00
Thorshavn	July	0.28±0.01
- " -	Nov	0.15

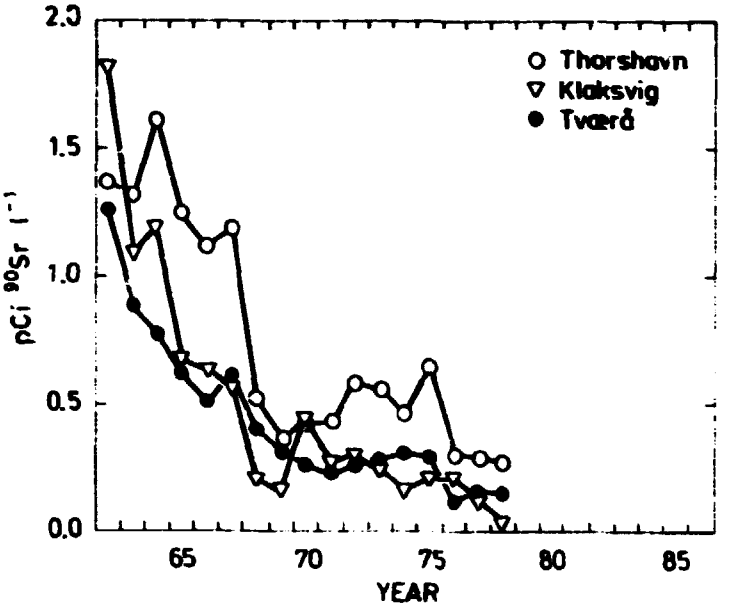

Fig. 2.6.1. Strontium-90 in drinking water from the Faroes, 1962-1978.

2.7. Strontium-90 and Cesium-137 in miscellaneous samples

2.7.1. Soil. No soil samples were collected in 1978 from the Faroes. From earlier years observations we estimate the accumulated fallout at Thorshavn to be 61 mCi ^{90}Sr km^{-2} and that at Klaksvig to be 122 mCi ^{90}Sr km^{-2}.

2.7.2. Sea water. Surface sea water was collected near Thorshavn on four occasions in 1978. The ^{90}Sr mean level was 0.075 pCi ^{90}Sr l^{-1}. (1 S.E.: 0.005).

Figure 2.7.2 shows the ^{90}Sr levels since 1962.

Table 2.7.2. Strontium-90 and Cesium-137 in sea water from the Faroes in 1978

Sampling month	^{90}Sr pCi l^{-1}	^{137}Cs pCi l^{-1}	Salinity o/oo
March	0.08	0.13	36.9
August	0.07	0.12	36.9

The samples were also analysed for ^{137}Cs. The mean was 0.125 ± 0.005 pCi ^{137}Cs l^{-1}. The $^{137}Cs/^{90}Sr$ ratio was 1.67 ± 0.04, i.e. a little higher than expected in ocean water. We assume the enhanced ^{137}Cs levels to originate from Windscale.

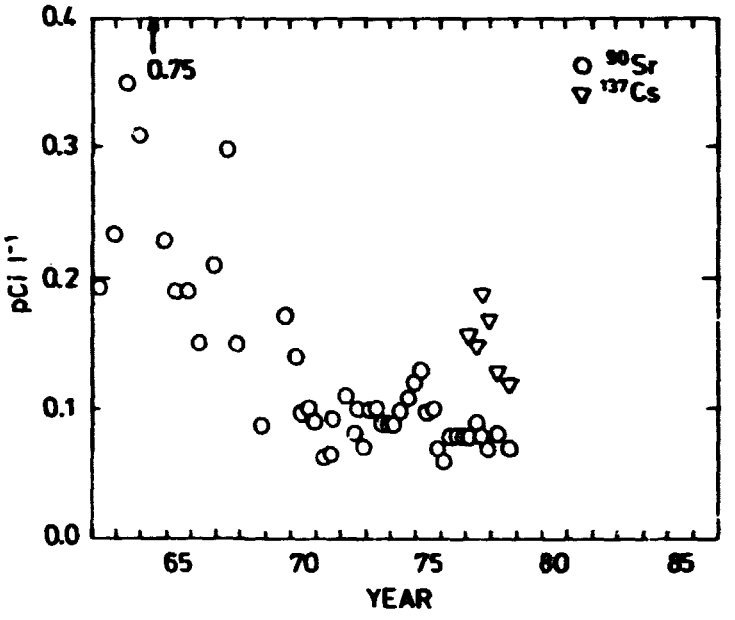

Fig. 2.7.2. Strontium-90 and Cesium-137 in Faroese sea water, 1962-1978.

2.7.3. Sea plants. Two samples of sea weed were analysed in 1978. Table 2.7.3 shows the ^{90}Sr and the ^{137}Cs determinations. The levels were similar to those of previous years, as was to be expected from the nearly constant sea water levels.

Table 2.7.3. Strontium-90 and Cesium-137 in Laminaria Hyperborea from the Faroes in 1978

Sampling month	pCi ^{90}Sr (g ash)$^{-1}$	pCi ^{90}Sr (g Ca)$^{-1}$	pCi ^{137}Cs (g ash)$^{-1}$	pCi ^{137}Cs (g K)$^{-1}$
March	0.108	1.95	0.221	0.87
August	1.45	17.5	0.199 A	1.78 A

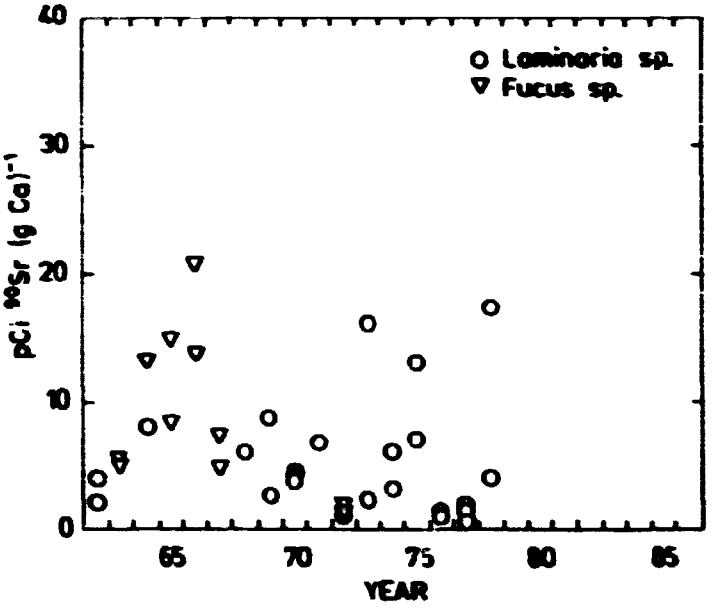

Fig. 2.7.3. Strontium-90 (pCi (g Ca)$^{-1}$) in sea plants collected at Thorshavn, 1962-1978.

2.7.4. Vegetables. Table 2.7.4 shows the results of the ^{90}Sr and ^{137}Cs determinations.

The ^{137}Cs mean level in potatoes (159 pCi kg^{-1}) was higher than that observed in 1977, but the ^{90}Sr level (6.9 pCi kg^{-1}) was lower. The ^{90}Sr levels in cabbage and carrots were close to the Danish levels[2] while the ^{137}Cs levels were respectively 2 and 4 times higher in the Faroes produce.

Table 2.7.4. Strontium-90 and Cesium-137 in vegetables and potatoes from the Faroes in September 1978

Species	Location	pCi ^{90}Sr kg^{-1}	pCi ^{90}Sr (g Ca)$^{-1}$	pCi ^{137}Cs kg^{-1}	pCi ^{137}Cs (g K)$^{-1}$
Spring cabbage	-	7.0	16.8	3.2 A	0.90 A
Carrot	-	6.1	28	6.7	-
Potatoes	Tvøri	4.0	207	199	64
- " -	Klaksvig	8.6	383	123	39
- " -	Thorshavn	8.0	272	154	44

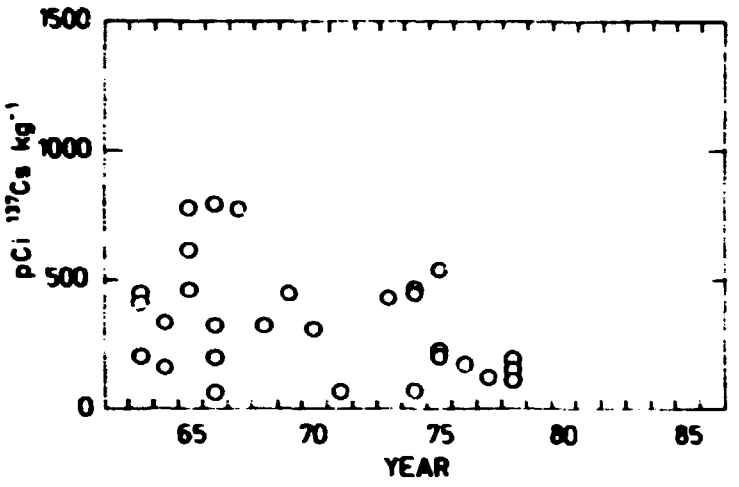

Fig. 2.7.4.1. Cesium-137 in Faroese potatoes, 1962-1978.

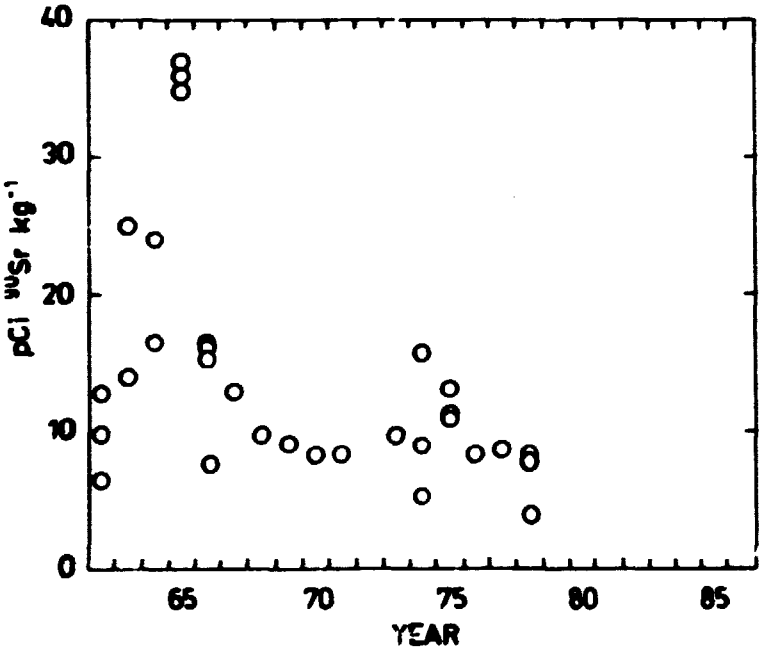

Fig. 2.7.4.2. Strontium-90 in Faroese potatoes, 1962-1978.

2.7.5. Bread. As in previous years[1], rye bread and white bread were collected at Thorshavn in July and December. The mean levels in white bread were 3.8 pCi ^{90}Sr kg^{-1} and 7.5 pCi ^{137}Cs kg^{-1}. The rye bread collected in 1978 contained on the average 8.4 pCi ^{90}Sr kg^{-1} and 17.5 pCi ^{137}Cs kg^{-1}, i.e. the bread levels were generally a little higher than the 1977 levels.

The ^{137}Cs levels in Faroese bread were nearly equal to the corresponding Danish[2], but the ^{90}Sr concentrations were lower in Faroese bread.

Table 2.7.5. Strontium-90 and Cesium-137 in Faroese bread in 1978

Month	Sort	pCi ^{90}Sr kg^{-1}	pCi ^{90}Sr (g Ca)$^{-1}$	pCi ^{137}Cs kg^{-1}	pCi ^{137}Cs (g K)$^{-1}$
June	White bread	5.0	2.1	8.8	3.9
June	Rye bread	10.3	3.8	17.4	8.2
Dec	White bread	2.6	1.6	6.2	4.0
Dec	Rye bread	6.4	3.0	17.5	7.7

2.7.6. Eggs. Eggs were collected from Thorshavn in June and December 1978. Table 2.7.6 shows the results. The mean levels of hens eggs were 1.0 pCi ^{90}Sr kg (1.8 S.U.) and 3.3 pCi ^{137}Cs/kg, i.e. a little lower than those of last year.

Table 2.7.6. Strontium-90 and Cesium-137 in hens eggs from the Faroes in 1978

Month	^{90}Sr pCi kg^{-1}	^{90}Sr pCi (g Ca)$^{-1}$	pCi ^{137}Cs kg^{-1}	pCi ^{137}Cs (g K)$^{-1}$
June	1.24	2.2	4.5 A	3.7 A
Dec	0.75 A	1.41 A	2.1 B	1.5 B

2.8. Humans

2.8.1. Strontium-90 in human bone. In 1978 five human bone samples representing 10 individuals from Dronning Alexandrine's Hospital in Thorshavn were analysed. Table 2.8.1 shows the results.

Table 2.8.1. Strontium-90 in human vertebrae collected in the Faroes in 1978

Age	Month of death	Sex	pCi ^{90}Sr (g Ca)$^{-1}$ (±1 SE)
0-5 days	1,2,3	2F,3M	0.97*
3.5 and 1.5 months	2	M	1.09**
70 years		M	1.28±0.06$^{\Delta}$
69 years		F	1.71$^{\Delta}$
80 years		M	1.28$^{\Delta}$

* 5 samples combined in one analysis.

**2 samples combined in one analysis.

$^{\Delta}$ Femur (from amputation).

The level in bone of newborn infants was 0.97 pCi ^{90}Sr/g Ca. In adult human vertebrae bone from the Faroes the mean level was estimated at 2.2 pCi ^{90}Sr (g Ca)$^{-1}$, i.e. 1.6 times the mean level observed in the three femur samples. The ratio 1.6 was that observed in adult bone in U.S.A. in 1976[5]. The Faroese adult bone level was thus twice the Danish[2], which is compatible with the ratio between the ^{90}Sr levels in Faroese and Danish diets.

3. ESTIMATE OF THE MEAN CONTENTS OF ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET

3.1. Annual quantities

The annual quantities are still based on the estimated made by Professor E. Hoff-Jørgensen, Ph.D., in 1962[1] of a daily per capita intake of approx. 3000 calories.

3.2. Milk and cream

75% of the milk consumed in the Faroes is assumed to be of local origin, and 25% comes from Denmark. Hence the ^{90}Sr content in milk consumed in the Faroes in 1978 was $1.2 \cdot (0.75 \cdot 8.3 + 0.25 \cdot 3.2) = 8.4$ pCi ^{90}Sr kg^{-1}, and the ^{137}Cs content was $0.75 \cdot 179 + 0.25 \cdot 7.0 = 136$ pCi ^{137}Cs kg^{-1} (cf. 2.3 and ref. 2). 1 kg milk contains 1.2 g Ca.

3.3. Cheese

Nearly all cheese consumed in the Faroes is of Danish origin, and the Danish figures from ref. 2 were used: 27.2 pCi ^{90}Sr kg^{-1} and 5.0 pCi ^{137}Cs kg^{-1}.

3.4. Grain products

As most grain products are imported from Denmark, the Danish figures for 1978[2] were used in the calculation of the Faroese levels. The mean daily consumption of grain products in the Faroes is, as in Denmark, 80 g rye flour, 120 g wheat flour, and 20 g grits. Hence the mean concentration of ^{90}Sr in grain

products consumed in the Faroes in 1978 is 12.9 pCi ^{90}Sr kg^{-1} and 16.5 pCi ^{137}Cs kg^{-1}.

3.5. Potatoes

All potatoes consumed in the Faroes are assumed to be of local origin. The values from table 2.7.4 were used, i.e. 6.9 pCi ^{90}Sr kg^{-1} and 159 pCi ^{137}Cs kg^{-1}.

3.6. Other vegetables and fruit

As the amount of vegetables and fruit grown in the Faroes is limited, the Danish figures from 1978[2)] were used. Thus the mean contents in vegetables other than potatoes were 7.0 pCi ^{90}Sr kg^{-1} and 1.7 pCi ^{137}Cs kg^{-1}, and the mean contents in fruit were 1.8 pCi ^{90}Sr kg^{-1} and 2.7 pCi ^{137}Cs kg^{-1}.

3.7. Meat and eggs

Meat and egg consumption in the Faroes is estimated to consist of 50% locally-produced mutton (or lamb), 25% local whale meat, and 25% sea birds and eggs.

The mutton contained 3.9 pCi ^{90}Sr kg^{-1} and 1.02 nCi ^{137}Cs kg^{-1} (cf. 2.4). Whale meat from 1978 contained 0 pCi $^{90}Sr/kg$ and 29 pCi ^{137}Cs kg^{-1}, sea birds from 1978 and eggs (cf. 2.7.6): 0 pCi ^{90}Sr kg^{-1} and 1.0 pCi ^{90}Sr kg^{-1}, and 11 and 3.3 pCi ^{137}Cs kg^{-1} respectively.

Hence we estimate the mean content of ^{90}Sr in meat and eggs consumed in 1978 to be

$$0.50 \cdot 3.9 + 0.25 \cdot 0 + 0.25 \cdot \left(\frac{0 + 1.0}{2}\right) = 2.1 \text{ pCi } ^{90}Sr \text{ } kg^{-1}$$

and the ^{137}Cs content to be

$$0.50 \cdot 1020 + 0.25 \cdot 29 + 0.25 \cdot 7 = 519 \text{ pCi } ^{137}Cs \text{ } kg^{-1}.$$

3.8. Fish

All fish consumed in the Faroes is of local origin, and the mean contents in fish, obtained from subsection 2.5, were 0.24 pCi $^{90}Sr\ kg^{-1}$ and 7.9 pCi $^{137}Cs\ kg^{-1}$.

3.9. Coffee and tea

The Danish figures for 1978[2] were used, i.e. 29 pCi $^{90}Sr\ kg^{-1}$ and 71 pCi $^{137}Cs\ kg^{-1}$.

3.10. Drinking water

The mean value found in table 2.6.1 was used, i.e. 0.15 pCi $^{90}Sr\ l^{-1}$. The ^{137}Cs content was estimated to be approx. one fourth (the ratio found in New York tap water in 1964[4]) of the ^{90}Sr content, i.e. 0.04 pCi $^{137}Cs\ l^{-1}$.

Tables 3.1 and 3.2 show the diet estimates of ^{90}Sr and ^{137}Cs respectively.

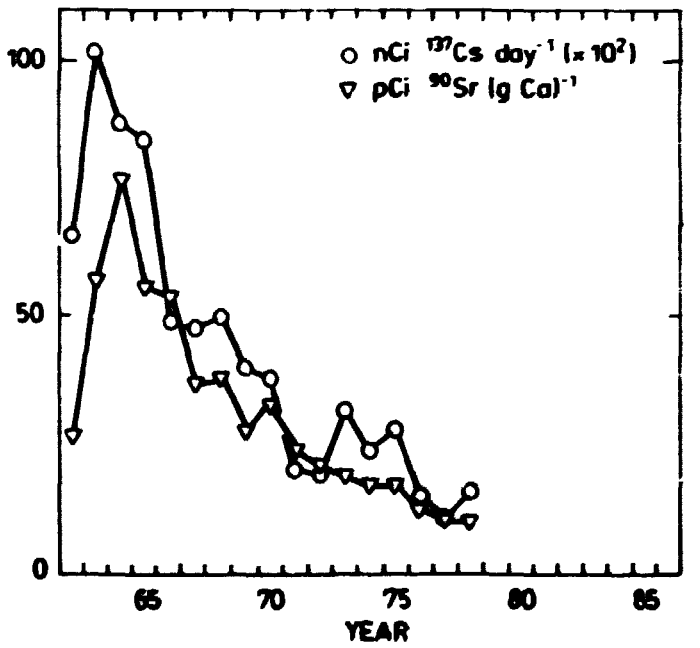

Fig. 3. Strontium-90 and Cesium-137 in Faroese diet, 1962-1978.

Table 3.1. Estimate of the mean content of ^{90}Sr in the human diet in the Faroes in 1978

Type of food	Annual quantity in kg	pCi ^{90}Sr per kg	Total pCi ^{90}Sr	Percentage of total ^{90}Sr in food
Milk and cream	146	8.4	1226	33.6
Cheese	7.3	27.2	199	5.5
Grain products	80	12.9	1032	28.3
Potatoes	91	6.9	628	17.2
Vegetables	20	7.0	140	3.8
Fruit	18	1.8	32	0.9
Meat and eggs	37	2.1	78	2.1
Fish	91	0.24	22	0.6
Coffee and tea	7.3	29	212	5.8
Drinking water	548	0.15	82	2.2
Total			3651	

The mean annual calcium intake is estimated to be 600 g (approx. 200-250 g of creta praeparata). Hence the pCi ^{90}Sr (g Ca)$^{-1}$ ratio in the total Faroese diet was 6.1 S.U., and the mean daily intake was 10 pCi ^{90}Sr.

Table 3.2. Estimate of the mean content of ^{137}Cs in the human diet in the Faroes in 1978

Type of food	Annual quantity in kg	pCi ^{137}Cs per kg	Total pCi ^{137}Cs	Percentage of total ^{137}Cs in food
Milk and cream	146	136	19856	35.3
Cheese	7.3	5.0	36	0.1
Grain products	80	16.5	1320	2.4
Potatoes	91	159	14469	25.7
Vegetables	20	1.7	34	0.1
Fruit	18	2.7	49	0.1
Meat and eggs	37	519	19203	34.1
Fish	91	7.9	719	1.3
Coffee and tea	7.3	71	518	0.9
Drinking water	548	0.04	22	0
Total			56226	

The mean annual intake of potassium is estimated to be approx. 1200 g. Hence the pCi ^{137}Cs (g K)$^{-1}$ ratio becomes 47 and the daily intake of ^{137}Cs 154 pCi.

3.11. Discussion

Figure 3 shows the Faroese diet levels since 1962.

The 1978 ^{90}Sr level in the total diet was 96% of the 1977 concentration, and the ^{137}Cs level was 142% of that observed in 1977.

The main contributors to the ^{90}Sr content in the Faroese diet were milk products, cereals and potatoes, which together accounted for approx. 85% of the total ^{90}Sr content in the diet in 1978. As regards ^{137}Cs, milk products, meat (lamb) and potatoes were the most important contributors. In 1978, 95% of the total ^{137}Cs content in the diet originated from these products.

The Faroese mean diet contained 1.4 times as much ^{90}Sr and approx. 9 times as much ^{137}Cs as the Danish diet in 1978[2].

4. CONCLUSION

4.1.

The ^{90}Sr fallout rate in the Faroes in 1978 was approx. 1.2 mCi $^{90}Sr/km^2$. The accumulated fallout by the end of 1978 was estimated at approx. 104 mCi $^{90}Sr/km^2$ (the mean at Thorshavn and Klaksvig).

4.2.

The mean level of ^{90}Sr in Faroese milk was 8.3 S.U. or 10 pCi $^{90}Sr\ l^{-1}$. The ^{137}Cs concentration was 110 pCi $^{137}Cs\ (g\ K)^{-1}$, or 179 pCi $^{137}Cs\ l^{-1}$.

Mutton contained 3.9 pCi $^{90}Sr\ kg^{-1}$ and 1.02 nCi $^{137}Cs\ kg^{-1}$. Fish showed mean levels of 0.24 pCi $^{90}Sr\ kg^{-1}$ and 7.9 pCi $^{137}Cs\ kg^{-1}$.

The mean content of ^{90}Sr in drinking water was 0.15 pCi l^{-1}.

The mean daily per capita intakes resulting from the Faroeses diet in 1978 were estimated at 10 pCi ^{90}Sr (6.1 S.U.) and 154 pCi ^{137}Cs (47 pCi $^{137}Cs\ (g\ K)^{-1}$.

4.3.

From the Faroese and Danish diet estimates and from measurements on Faroese and Danish bones, the Faroese bone levels in 1978 were estimated as follows: in newborn infants: approx. 1 S.U.; in small children (1 month - 4 years): approx. 1-2 S.U. (depending upon the amount of locally produced milk in the diet of

the infants); in children and teenagers (5 - 19 years): approx. 1-2 S.U.; in adult vertebrae: approx. 1-2 S.U.

The mean content of ^{137}Cs in the Faroese adult was estimated at approx. 100-150 pCi ^{137}Cs/g K. This estimate is based on the diet estimate.

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